OBSERVATIONS ON THE STRUCTURE OF THE MANATEE.

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Although in 1872 there appeared in the Transactions of the Zoological Society of London a most admirable paper "On the Form and Structure of the Manatee," by Dr. Murie, as I have been lately engaged in the dissection of the Manatees, Manatus Americanus, that died at the Zoological Garden of Philadelphia, and as I believe this is the first time that the opportunity has presented itself of studying fresh specimens, I think it not superfluous to call attention to some of my results. As that excellent anatomist, Dr. Murie, has very fully illustrated the anatomy of the Manatee in the paper just mentioned, and refers frequently in it to the literature of the subject, I shall limit myself to either confirming his observations save in some points, or endeavoring to supplement what is wanting in his paper, as, his specimens having been opened on shipboard, some of the parts were thereby either injured or decomposed, rendering them unfortunately unsatisfactory for dissection.

The Position of the Manatee in the Animal Kingdom.—I agree with most naturalists in considering it and the Dugong as the representatives of a distinct order, the Sirenia, regarding their geographical distribution, food, structure of the skin, skeleton, position of the nares, and mammæ, the organs of alimentation, circulation, the uro-genital apparatus, as entirely separating them from the Cetacea, with which they were combined by Cuvier and are still by Profs. Hæckel, Carus, etc. While in some respects the Sirenia are undoubtedly akin to the Pachydermata, De Blainville likening them to the Proboscidea, others to the Hippopotamus, in the present state of Biology I think it impossible to indicate the exact relationship, there being no transitional form to bridge over the gulf as the Zeuglodon does in the case of the Carnivora and Cetacea, and so provisionally it appears to me that the order Sirenia must be preserved.

Sex, Length of Animals.—The animals dissected by me were both males, one measured exactly 6 feet from snout to tip of tail, the other $6\frac{1}{2}$ feet. Their general appearance, the color of the

creatures, character of the skin and hair, etc., were illustrations of the truthful description given by Dr. Murie.

Osseous and Muscular Systems.—As regards the osseous system I have nothing new to offer, merely observing that I found only 6 cervical vertebræ, and that I agree with Dr. Murie in regarding the 3d cervical as the missing one. To those interested in the Myology of the Manatee, I would refer them to the paper of Dr. Murie, where good comparisons are made between its muscles and those of the Elephant and Cetacea. Plate 21, however, does not give exactly the color of the muscles as observed in my specimens, which were rather redder than the brownish tint there depicted.

Nervous System.—Of the many subjects in anatomy for future investigation, perhaps none surpasses in interest or importance a thorough study of the Sirenian brain, not only in reference to the completing our knowledge of the structure of the Sirenia, but as offering additional data for the determination of their relative position among the other Mammalia. At page 180 of his paper, Dr. Murie states that "the encephalon of the younger male was so destroyed as to be unfit for examination; while the membranes surrounded the brain of the female specimen, a tolerably accurate idea of the cerebral contour was got; but on raising the dura mater, the brain itself was found to be softened and with difficulty extracted. No measurements or weight were taken, but the whole placed in spirit as rapidly as possible; a cast of the cranial cavity with its inclosed dura mater was subsequently made, and by the help of the cast and the shrunken brain, the sketches were drawn." Such being the state of the brain in Dr. Murie's specimen, I took the earliest opportunity of examining those of mine. As the brain in my smallest Manatee seemed to have suffered from some compression affecting the symmetry of the anterior lobes and somewhat flattening them, I used it for making sections, keeping the brain of the largest Manatee, which was quite normal and in excellent condition, for description externally. From the latter specimen the figures (Plate 26) have been drawn. After removing the dura mater, which was very tough, what at once struck me, on looking at the brain *in sitû*, was the absence of either numerous or deep fissures and folds. The elevation of the cerebellum as compared with that of the cerebrum (not so well seen after removal from the skull) is greater than that figured by Dr. Murie, the amount of the cerebellum left uncovered by the cerebrum is more

considerable. The brain as a whole resembled somewhat that of a beaver or porcupine, the general figure of the cerebrum being more Rodent-like than "Elephantine," as Dr. Murie describes that of his specimen at p. 181; but in truth, taking it all in all, the brain of the Manatee is *sui generis*, not looking like any brain I have dissected, seen preserved, or figured. Dr. Murie, at p. 183, refers to some figure of the Dugong's brain, but as he gives no reference and as I know of no such figure, I cannot make any comparison. The general figure of the cerebrum is quadrangular, but rounded off at the corners, as Dr. Murie expresses it, the lobes sloping gently downward from before backward. The height of the cerebrum in profile in the middle of the anterior lobes is $2\frac{1}{2}$ inches, the length of cerebrum 3 inches, the breadth through middle lobes $3\frac{1}{4}$ inches. The height of the cerebellum is $1\frac{5}{8}$ inches. The difference between the height of the cerebrum and cerebellum is less therefore than that of the brain represented by Dr. Murie.

As regards the cerebrum, I had no difficulty in recognizing frontal, parietal, temporal, and occipital lobes, the frontal lobes being enormous. The hemispheres are separated by a deep longitudinal fissure; equally striking is the Sylvian fissure dividing each hemisphere into an anterior and posterior half. As regards the remaining fissures and folds I cannot say that I found them as well marked as those represented by Dr. Murie in Figs. 31, 32, Plate 25. Indeed the smoothness of both the brains examined by me is most remarkable. I identified, however, the fissures of Rolando, the Hippocampal and the Calloso Marginal. I refrain from naming the remaining ones, as I am not satisfied as to their homologies with those of the brains of other Mammalia. The olfactory nerves are of good size, with well-developed bulbs. This is in harmony with their sense of smell, which I think is acute, having noticed with Mr. Thompson, Superintendent of the Garden, that the Manatee seemed to recognize at once that its food had been put in the aquarium by its sense of smell rather than by its sight or hearing, which were apparently rather defective. The optic nerves are small. The pituitary body is large, but the corpora albicantia are not well differentiated. The 3d pair of nerves are of fair size. What I took to be the 4th is a very delicate filament. The 5th is relatively and absolutely very large. If Dr. Murie has correctly described the 6th, its origin, direction, and size are very peculiar. It is possible, however, that the 6th

is absent in the Manatee, as I found no trace of it at its usual origin. If such is the case, I should regard Murie's 6th nerve as the 7th, and his 8th as the pars intermedia; his 7th would then be 8th. I was unable to trace out these nerves, being anxious to take out the brain as soon as possible. The glosso-pharyngeal, pneumogastric, and spinal accessory were readily recognized. The hypoglossal came off internally and above the position represented by Dr. Murie in Fig. 33, Plate 25. On making sections I found the corpus callosum extending but little posteriorly; the fornix was well developed, particularly the posterior part. The lateral ventricle is long and deep, the anterior and middle corner very apparent, while there is a beginning of a posterior one. The corpus striatum is well developed, as also the thalamus opticus. There is a delicate tænia semicircularis. The choroid plexus is rich. The hippocampus major is present, but not as thick relatively as the hippocampus minor. There is apparently a corpus fimbriatum. The velum interpositum was well injected, and on removal revealed the pineal gland with its peduncle. The 3d ventricle is deep. The corpora quadrigemina are large, but are really bigeminal bodies, there being only a slight indication of division into nates and testes. The processui e cerebello ad testes are well seen, supporting a firm valve of Vieussens, under which a bristle readily passed from the 4th to the 3d ventricle. The cerebellum is higher, as I have already mentioned, and broader than that represented by Dr. Murie, almost as broad as the cerebrum, its breadth being 3 inches. I noticed in its vermiform process, the floculus and the amygdaloid bodies. The pons and medulla are both flat, but the olivary and restiform bodies are, however, distinguishable. The brain weighed 7 ounces 14 drachms av. In reference to the distribution of the cranial nerves I have nothing new to offer. As regards the cervical plexus, I found its disposition to be the same as described by Dr. Murie, noticing the interesting peculiarity of the 3d and 4th cervical nerves, emerging together from between two contiguous vertebræ, viz., the 2d and 4th. The missing vertebra I regard, with Dr. Murie, as being the 3d. For since the 8th cervical nerve, contributing to form the brachial plexus, escapes from between the 1st dorsal and a contiguous vertebra, which must, therefore, be the 7th cervical, and as the 7th, 6th, and 5th cervical nerves emerge from between contiguous vertebræ, which must for the same reason be the 7th, 6th, and

5th cervical vertebræ, the vertebra next to the 5th must be the 4th, for if it were the 3d, then the 4th and 5th cervical nerves would escape together, instead of the 3d and 4th, the atlas and axis, from their characteristic forms, being unmistakable. As regards the brachial plexus and nerves of the upper extremities, I have nothing new to offer.

Alimentary Apparatus.—As regards the parotid, submaxillary, and what Dr. Murie considers as sub-lingual glands, I have nothing further to say; inasmuch, however, as that writer states at page 170, "that the stomach had been cut open and the contents removed," I may mention that I found the stomach as well as the intestines in both specimens more or less filled with the partially digested fresh-water plants, principally Valesneria spiralis, upon which the animal had been feeding, and that the compound stomach of the smaller Manatee measured in its greater curvature $18\frac{1}{2}$ inches, in its lesser curvature $15\frac{1}{2}$. In reference to its division into cardiac and pyloric portions, the number and shape of its pouches, the œsophageal sphincter, I have nothing to add to what has already been described. As my smallest Manatee measured exactly 6 feet, while the largest of Dr. Murie's was 65 inches, it was to be expected that the intestines in my specimens would be longer than in his. While the small intestine in his specimen was 25 feet long, in mine it was 33 feet 4 inches, the average diameter was about 1 inch. The cæcum in the smallest specimen was 5 inches long, measuring from a point midway between the teats, and 6 inches wide. The teats themselves exhibited the usual conical form, and were 5 inches in length. The large intestine in my smallest specimen gave me a length of 27 feet 2 inches; that of Dr. Murie, male and female, 18 and 17 feet respectively, average diameter in mine was $1\frac{2}{8}$ inches.[1]

At page 173 Dr. Murie states "that the liver of the larger specimen had been hacked in pieces," but that "in the younger male this gland was more intact," and a few lines below observes that "the entire liver has great resemblance in shape to the inflated lungs of an ordinary mammal." I think this comparison a very good one, not only as regards the general form but also in the color, which was quite lung-like. The form of the liver differed

[1] The large intestine of the largest Manatee was filled with parasites representative of the Amphistomum fabaceum of Diesing.

but little from that of the Dugong as described by Prof. Owen. The gland *in situ* extended completely across the abdominal cavity, and measured in the smallest specimen from edge of right lobe to that of left 14 inches; the breadth of the right and left lobes was respectively $7\frac{1}{2}$ and $6\frac{1}{2}$ inches, their depth fore and aft 8 inches and 7 inches. The liver in the smallest specimen weighed 2 pounds $14\frac{1}{2}$ ounces av. I have nothing to add about the gall-bladder save to notice its presence. The pancreas, $6\frac{1}{2}$ inches long, was much lobulated, and, as Dr. Murie states, pale but firm in consistence. Ductus communis choledochus in both my specimens opened into intestine close to the pylorus, while the pancreatic duct opened $1\frac{1}{2}$ inches from the ductus communis. This disposition is different from that noticed by Dr. Murie, he stating at page 173, in speaking of the pancreas, "its duct opens into the intestine close to the pylorus," while at page 174 he says "the ductus communis choledochus penetrates the intestine about 3 inches from the pylorus."

Dr. Murie does not refer to the spleen. I found it in its usual position, but was struck with its very small size, it measuring in the smallest animal only $2\frac{1}{2}$ inches long and 1 inch wide. In form it was oval and of the usual color. Unfortunately the spleen of the Sirenia sheds no light which will help to clear up the difficulties which envelop any explanation of the general physiology of this organ. Its small size, as in the Cetacea, is not in harmony with the idea of its being either the birthplace or the grave of the red corpuscles (which in the Manatee I noticed were very numerous, though in other respects they presented nothing peculiar), while it is in direct contradiction with the theory held by some physiologists of the organ holding blood as a sponge to be pressed out by the distended stomach when needed in digestion.

Respiratory Apparatus.—As the peculiar disposition of the diaphragm and the characters of the respiratory organs generally have often been described, I will limit myself here to simply giving measurements. The trachea of the smallest specimen was 4 inches long from the larynx to where it bifurcates. The right bronchus measured 6 inches in length, the right lung 25 inches, the left bronchus 5 inches, the left lung 27 inches. The bronchi in my specimen are more oblique than as represented by Dr. Murie. I have nothing new to offer in reference to the larynx. I noticed the usual muscles were well developed.

Circulatory Apparatus.—As my smallest specimen was very well injected by Mr. Nash, the preparateur of the University Museum, I took interest in comparing the great bloodvessels and various rete mirabile with those described and handsomely figured by Dr. Murie, and found his account a very satisfactory one I must state, however, that the rete mirabile, figured by Dr. Murie in Plate 24, Fig. 30, as lying immediately underneath and alongside of the trachea and upper portion of the bronchi, was absent in my specimen. I cannot attribute this difference to want of the vessels being filled in my specimen, as the other rete, such as the cervical, cranial, spinal, axillary, brachial, thoracic, intercostal, caudal, etc., were well injected, so that without questioning the correctness of Dr. Murie's plate as illustrating his dissection, I simply state that in this respect it does not give exactly the idea of mine. As Dr. Murie gives measurements of the bifid heart when empty, I offer the following as the size of that organ when distended with the injected material: Width of heart through auricles, measured across aorta and pulmonary artery, 7 inches; the width of aorta was a little over an inch, that of pulmonary artery $1\frac{1}{2}$ inch; width of heart through ventricles $6\frac{1}{2}$ inches. It is interesting to notice the presence of the two superior venæ cavæ, the right one opening into the auricle above, the left one below.

Uro-genital Apparatus.—Among the striking differences that the Sirenia offer as contrasted with the Cetacea, none deserve more notice than the urinary and generative organs. As is well known, the kidney in the Cetacea is much lobulated, whereas in the Manatee no trace of such lobulation is perceptible. The kidneys in the smallest Manatee dissected by me were 6 inches long and 3 inches wide; the ureters of the same diameter throughout measured 10 inches in length from bladder to pelvis. As the male generative organs have been described, and partly figured by Vrolik, I merely mention that the penis in my specimen measured 12 inches in length, and that the ischio cavernosus, bulbo urethræ, and retractor penis muscles were well developed. The seminal vesicles which are absent in the Cetacea were 2 inches long in my specimen. The vas deferens from point of union with duct of seminal vesicle to epididymis measured 8 inches; the testicle, 3 inches long, was somewhat indented, giving the gland the appearance of consisting of two or three bodies.

Habits of the Manatee.—A great disideratum for a long time in

every Zoological Garden has been a Manatee, and as the opportunity of studying them living in confinement has presented itself for the first time anywhere, I think it important to call attention to the manner in which the curious creatures were brought to the Zoological Society of Philadelphia, their habits while living there, and the cause of their death as far as I could learn. I am indebted to Mr. Thompson, Superintendent of the Garden, for the use of his daily diary, from which most of the following facts are taken. The two Manatees were brought from Demerara in separate wooden tanks to Baltimore, and from there to Philadelphia, arriving here August 4th. The tanks were placed under the trees, and the water being at once let out they were re-filled with fresh water from the Schuylkill River. The animals seemed to enjoy the fresh water, swimming about and rolling over and over. Some of the plant Valesneria spiralis gathered from the river was placed in the tanks, and the animals immediately rose to the surface and began to feed, fanning, as it were, the food into their mouths by means of the bristles situated on their upper and lower lips; these bristles spreading out when in use so as to look very much like small fans. The smaller Manatee ate more than the larger one, which was natural, the large one having eaten heartily of grass and ship biscuit before leaving Baltimore in the morning. The tanks were then so arranged that a small stream of fresh water at a temperature of 70° Fahr. could flow constantly through them. Twice during the evening the creatures were visited, and seen to rise at regular intervals to the surface and feed kindly. The following morning, August 5th, the Manatees had eaten all the plant left in the tanks the night before. The creatures from time to time rose to the surface, fanned the grass into their mouth, then sank slowly to the bottom, chewing their food very slowly. August 6th, 7th, 8th, and 9th nothing new had been noticed. On the 10th the large Manatee had eaten, by weight, 21 pounds of Valesneria spiralis in 24 hours. On the 11th a little ceratophyllum was mixed with the valesneria. It was all gone the following day in the tank of the larger Manatee, and had been partially eaten by the smaller one. On the 14th a little sea-weed (Ulva latissima) was put in the tanks; this had all disappeared the next morning. By the 31st the large animal had become quite tame, rising to the surface to have its head scratched when the water was agitated. By September 4th the aquarium, built for the purpose in the carnivora house, and contain-

ing water three or four feet deep, was ready for the reception of the Manatees, and the animals were then shifted to it from the tanks in which they had been brought to the garden in the following manner. The water was first entirely drawn off, the tanks were then placed on a truck and water played in to the depth of 18 inches to prevent the animals from bruising themselves in floundering about. The truck with the tanks was then moved to the aquarium, two keepers got into the tank, passed a thick blanket under the Manatee, two keepers in the aquarium seized the blanket, and by a sloping platform from the tank the Manatees were successively slipped up and launched into the aquarium. In the course of a week the Manatees had become much tamer, not floundering as they formerly did when the water was let out of the aquarium, but allowing the keeper to sweep around them. On Sept. 23d the larger Manatee was very sluggish, lying upon the surface of the water, and it would not sink to the bottom or swim about. When it did move bubbles of air were seen to escape from the anus; the excrement was very hard. The animal seeming constipated, the keepers were directed to make it move about from time to time; whilst in motion there was a constant stream of ascending bubbles of air from the anus. At night-time, however, the animal seemed much better, and the next morning was playing about as usual. On the morning of September 28th the Manatees were apparently quite well, but at 9.30 A. M. the keeper going to clean out the aquarium, noticed that the large Manatee was quite sick, and the small one dead. On opening the animal the pericardial sac was found distended, filled with fluid, serous exudation, and other signs of inflammatory action. The remaining organs were perfectly healthy. The alimentary canal was full of the remains of the food the animal had been eating; but I do not regard this as pathological, since Steller, in speaking of the stomach of the Rhytina, notices that it "was distended with masticated sea-weed." The morning that the small Manatee died the temperature of the water, through unavoidable circumstances, was noticed to have fallen to 63° Fahr., the usual temperature being 70° to 71°. It must be mentioned, however, that on August 25th the water was only 66°, and yet the animals did not seem to be inconvenienced. The change of temperature, however, on that occasion was a gradual one. It seems, therefore, very probable

that the sudden change in the temperature of the water caused the illness of both the Manatees. The health of the smallest had never been as good as that of the largest and oldest; the cuticle peeling off; it not feeding well; often troubled with constipation, which was relieved by giving the animal the valesneria from the bottom of the tank, with the mud and pebbles adhering to it, etc. From the way in which it followed the largest one, getting under it as if to suckle, it seemed as if it had been captured too young. Apparently the largest Manatee had recovered from the illness which had killed the smallest, and seemed to be doing well, except in that its eyes were a little inflamed, which symptom was attended to, and it was hoped that it would live, but on the morning of October 15th it was found dead. The post-mortem showed that the heart had been affected in the same manner as the first one, and that the pleura and peritoneum and spinal marrow also exhibited signs of inflammation. Whether the largest Manatee had lived through the first attack on account of its comparatively good condition, and died from a more recent one, I cannot say positively, but the temperature of the water had been kept uniform since the smallest one had died. From the manner in which the Manatees grubbed about the bottom of the tank, nosing about like a pig, the extensibility of the snout being much greater than one would suppose, I am inclined to think that if a marine aquarium was built exactly suited to their habits, they would only be seen when rising to the surface to breathe, evidently liking the muddy better than the clear water. When not in motion the Manatee rested by the tip of his tail upon the floor of the aquarium, his head downward, and with the back much arched. At intervals of about one minute to one and a quarter he rose to breathe, and at that time the valves of the nose might be seen to open and shut again as the animal slowly sunk. One can readily understand, after seeing the lungs inflated, how easy it is for the animal to maintain its almost motionless position at variable depths of the water, the lungs acting very much like the air-bladder of fishes, and looking indeed more like the lungs of Lepidosteus than those of a Mammal. The Manatee will eat freely of cabbage, spinach, kale, baked apples, celery tops, etc. When feeding, the curious fanning motion of the bristles on the lips can be well seen. The Manatee seems to be more like a gentle, harmless, stupid sort of water-pig than anything else, with the

senses little developed, that of smell being the best. Inasmuch as the Zoological Garden of Philadelphia has succeeded in keeping Manatees alive for two months and a half, let us hope that the effort will be again made here, and by other institutions of similar character, remembering with the poet—

"Nil actum reputans
Si quid superesset agendum."